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Abstract

The Capture of the Radioactive Noble Gases by the Clathrate Method

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It is important to treat safely the radioactive noble gases released from atomic power plants and the fuel reprocessings. These gases have been conventionally treated by the charcoal bed method, but, since these gases can't keep adsorbed with stability under the ordinary temperature and pressure, the method is not convenient for the storage and transport of the gas products.

Considering these shortcomings of the charcoal bed method pointed out above, the authors studied for the development of a new unit operation technique of the waste disposal of the radioactive noble gases using clathrate compounds. Laboratory scale experiments were performed in order to determine conditions, under which industrial scale processes could be made.

Hydroquinones are combined with each other by the intermolecule hydrogen bonds to make cages which have the suitable size for including other molecules such as noble gases and then make compounds of $3C_6H_4(OH)_2 \cdot M$ type which are called clathrate compound. From the formula represented above, the clathrate compounds prove to contain the noble gases 97.4ml.S.T.P./g in maximum, so that they have the absorption capacity compatible with that of the charcoal bed. They are not only convenient for storage and transport but appropriate to wide industrial applications, since they are stable under the ordinary temperature and pressure and decomposed on heating to release the radioactive noble gases.

In this work, various amounts of solutions saturated with hydroquinone at various temperatures were heated up to several degrees above the saturation tempe-

rature in atmosphere of the noble gases under various pressures, and then cooled to the room temperature at constant cooling rates. While the crystal was growing, the noble gases entered the cages of the clathrate compounds as mentioned above.

Of the nine solvents experimented, which were water, and eight other organic solvents which dissolve noble gases more readily than water, the first one gave the best result.

The experiments were performed in aqueous solution in detail to study important factors which have influences on crystal growth, (i) super solubility with and without crystal seeds and also in existance of other substances such as CH_3OH, CO_2 which can also be included in the clathrate compounds, (ii) stability of super cooled solutions, and (iii) the rate of crystal growth.

Two types of reactors, a batch type autoclave and a semi-continuous gas flow type reactor were used to investigate the effect of the experimental conditions on the noble gas contents in the clathrate compounds and the decontamination factor. The following experimental conditions were considered; the partial pressure of the noble gases, the flow rate of the noble gases, the cooling rate of the solution and the saturation temperature of the hydroquinone solution.

The results obtained from the experiments imply the possibility of the safe disposal of the radioactive noble gases by the clathrate method, since the gases can be compressed and held in a small space in place of dilution or mixing with other gases.